Challenges for open educational resources on biotechnology

Theme: Legitimacy of open educational resources. Processes of research and improvement of online content

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Abstract

Open Educational Resource is any educational resources that are openly available for use by educators and students, without an accompanying need to pay royalties or license fees. There is a potential in the OER to change the educational reality. Some of the classic features about teaching and learning can change with the OER movement and some examples are teacher and student roles; reduction of the importance of the textbook with restricted rights to use; adoption of Open Education Practices (OEP). However, three challenges appear: get open educational resources on Biotechnology, choose the educational resources and plan its use in teaching and learning processes. The objectives of this paper are to present a survey of open educational resources on biotechnology and discuss aspects to guide the assessment of its quality.

Keywords: Open Educational Resource; Biotechnology; Educational Website; Science Education; Teacher Training; Quality Assessment Model

Open educational resources (OER)PEN EDUCATIONAL RESOURCES (OER)

The term Open Educational Resources (OER) was coined at UNESCO's 2002 Forum on Open Courseware and designates

> teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. Open licensing is built within the existing framework of intellectual property rights as defined by relevant international conventions and respects the authorship of the work (UNESCO, 2012).

This 1st Global OER Forum was motivated by the increasing number of institutions offering free or open courseware, after the Massachusetts Institute of Technology (MIT), in an unprecedented move, has announced the release of nearly all its courses on the internet for free access (UNESCO, 2002).

Kanwar, Uvalić-Trumbić, Butcher (2011, p. 5) accentuates the license as the only one key that differentiates an OER from any other educational resource - an OER is simply an educational resource that incorporates a license that facilitates reuse, and potentially adaptation, without first requesting permission from the copyright holder.

Importance of researching biotechnology's open educational resources

Malajovich (2011, p. 2) defines biotechnology, broadly, as an activity based on multidisciplinary knowledge, which uses biological agents to make useful products or solve problems. According to Silva Klein (2011, p. 21), biotechnology is considered a conceptual field because it involves a range of elements and concepts from different scientific fields of knowledge.

Genetic engineering and other biotech occupy today, according to Leite (2000, p. 40), the central place in the social representation of science, naming this century - or perhaps the next – as the Century of Biotechnology. The author (p. 46) identifies three levels of public ignorance about the conceptual field: basic concepts of biology and genetics, updating of knowledge, and ethical, legal and social implications.

Loreto and Sepel (2003) showed that high school is failing to enable the student to appropriate a clearer concept about DNA and therefore also on Biotechnology and related topics, the content set called New Biology, and training students able to apply knowledge in practical situations seems to be an even greater challenge for education. They also indicated (p. 154), six issues related to the teaching of the New Biology: knowledge of the New Biology grows at an astounding speed, so it is impossible to learn everything or be updated; inadequate or outdated training for teacher without domain or security to handle the basic concepts of the New Biology; abstract knowledge produced by methods with which the teacher had no contact; teaching based on the textbook and lectures, few experimental activities and active methodologies; and knowledge without context.

However, three challenges about Open Educational Resources on Biotechnology appear:

- Where to get open educational resources on Biotechnology?
- How teachers can choose the open educational resources?
- How can they be used in teaching and learning processes?

Beginning to answer these questions, the objectives of this paper are to present a survey of online open educational resources on biotechnology.

Online open educational resources on biotechnology: a survey attempt

Reflecting on the types of open educational resources identified by KANWAR, Uvalić-Trumbić, Butcher (2011, p. 5) - Curriculum Maps; Course Materials; Textbooks;

Multimedia Applications; Streaming Videos and Podcasts - it was possible to see interrelation between all them inside online courses.

The most recent phenomena related with online courses are called Massive Open Online Courses (MOOCs). According with MOOC definition from EduTrends Report (Observatory of Educational Innovation, p. 3, 2014), it consists of classes delivered on a technological platform enabling the teaching-learning process for thousands of students. MOOC is a course of study made available over the Internet without charge to a very large number of people. (Oxford Dictionaries, 2015).

Biotechnology courses were searched from online directories[1] of Massive Open Online Courses (MOOCs) and all resources were classified this way:

- Curriculum Maps (CMAP): Curriculum Plans, Instructional Objectives, Competences, Standards and Objectives and Directions for Teachers;
- Course Materials (CMAT): Presentations, Assessments, Exercises, Reading Materials except Textbooks (TEXT);
- Multimedia Applications (MUAP): Simulations, Games and Graphic Design Material;
- Streaming Videos (STVI): all other multimedia resources, like recorded lectures and interviews;
- Podcasts (PODC): all audio contents.

Eleven courses were found, offered by different providers: EdX, Coursera, BiotechU, Saylor and Canvas.

Six courses had open enrollments on April, 2015' (Table 1) and five others were archived or without open sessions (Table 2)

Courses on Biotechnology: open sessions on April, 2015'	**OER**	**Providers (total courses)**
Biotechnology: Industrial Biotechnology (48 hours)	Any information	EdX (500 courses)
Introduction to Bioethics (40 hours)		

1 Onlire MOOC lists or Directories: https://www.mooc-list.com/; https://www.class-central.com/; http://www.moocsuniversity.org/; http://www.mooctracks.com/; http://www.technoduet.com/a-comprehensive-list-of-mooc-massive-open-online-courses-providers/; http://www.coursebuffet.com/; http://top5onlinecolleges.org/mooc/; https://www.oercommons.org/

Epigenetic Control of Gene Expression (64 hours)	CMAP	Coursera (1000 courses)
Think Biotech (7 hours)	CMAP; STVI	BiotechU (1 course)
Cell Culture Basics (4 weeks)	CMAP	Canvas (75 courses)
Biotechnology (140 hours)	CMAP; CMAT; TEXT; MUAP; PODC	Saylor (300 courses)

Table 1: Open sessions in April 2015: Course titles (and duration), OER available prior to enrollment and providers (with all courses offered)

Courses on Biotechnology: archived or no open sessions on April, 2015'	**OER**	**Providers (total courses)**
Technology for Biobased Products (56 hours);	Any information	EDX (A)
Genes and the Human Condition (From Behavior to Biotechnology) (48 hours);	CMAP; STVI	Coursera (NOS)
Drug Discovery, Development & Commercialization (36 hours);	CMAP	Coursera (NOS)
Experimental Methods in Systems Biology (64 hours)		
Introduction to Tissue Engineering (50 hours)		

Table 2: No open sessions in April 2015: Course titles (and duration), OER available prior to enrollment and providers (A – archived; NOS – no open sessions)

Saylor's course is an interesting case in which a quick look may cause future disappointment. Biotechnology course has only 140 hours. However, if its Curriculum Map is investigated, four prerequisites courses and one suggested course turns up. Biotechnology course is increased in another 540 or 570 hours (dependent on the choice between Microbiology or Cell Biology) and more 140 hours to make Biochemistry. Figure 1 is the image of the relationship between courses.

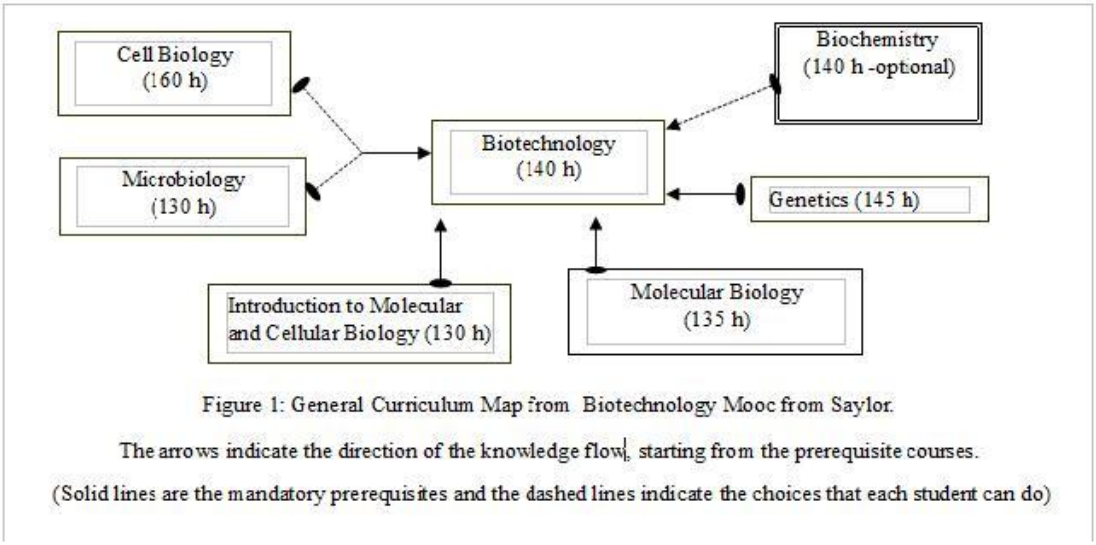

Figure 1: General Curriculum Map from Biotechnology Mooc from Saylor.

The arrows indicate the direction of the knowledge flow, starting from the prerequisite courses.

(Solid lines are the mandatory prerequisites and the dashed lines indicate the choices that each student can do)

But the case can worsen: after the investigation about prerequisites of these five courses, it was possible to build a big and diverse Academic MOOC Pathway, which is a good illustration about Biotechnology classification as a *conceptual field* (Silva Klein, op. Cit.).

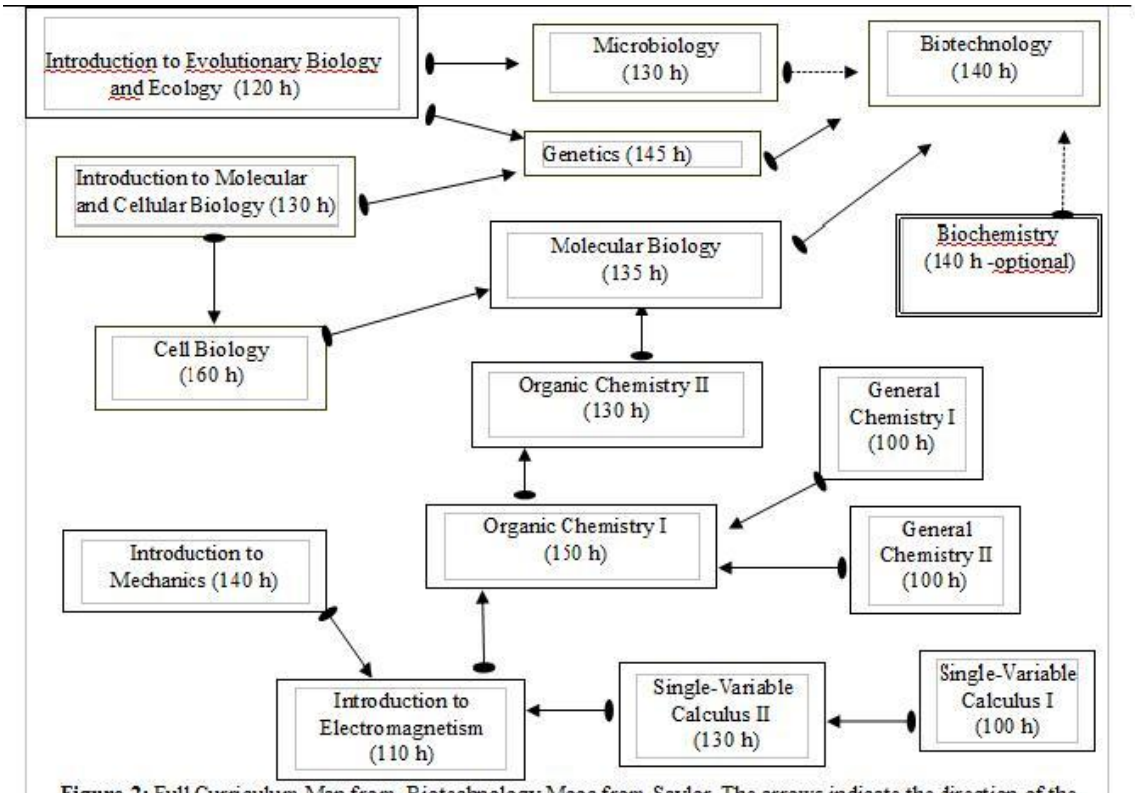

Figure 2: Full Curriculum Map from Biotechnology Mooc from Saylor. The arrows indicate the direction of the knowledge flow, starting from the prerequisite courses. (Solid lines are the mandatory prerequisites and the dashed lines indicate the choices that each student can do)

Figure 2 shows it's necessary to take more 1650 or 1780 hours (choose Microbiology), and more 140 hours for optional Biochemistry, to have all mandatory prerequisites. Thus, an online student may be enrolled in Biotechnology MOOC from Saylor. Even more, it shows Single-Variable Calculus I as the first course required. A graphical representation is fundamental to guide online students on the curricular organization of courses with prerequisites.

Massachusetts Institute of Technology provided, since 2002, the content of its courses in MIT Open Course Ware (OCW) provider. It is a web-based publication of virtually all MIT course content. OCW is open and available to the world and is a permanent MIT activity. There are materials from 2150 courses.

Searching the term biotechnology has resulted in 32 courses. All courses presented Curriculum Maps and Course Materials, some presented Streaming Videos and Podcasts. 18 courses were indicated for undergraduate level, 10 courses for graduate level and four were indicated for both levels. Molecular Structure of Biological Materials was the only course available in Spanish. Table 3 shows course titles.

Undergraduate level
American Science: Ethical Conflicts and Political Choices
Analysis of Biomolecular and Cellular Systems
Anthropology of Biology
Biological Computing: At the Crossroads of Engineering and Science
Designer Immunity: Lessons in Engineering the Immune System
Developmental and Molecular Biology of Regeneration
Experimental Molecular Biology: Biotechnology II
Freshman Seminar: Structural Basis of Genetic Material: Nucleic Acids
Fundamentals of Biology
Harnessing the Biosphere: Natural Products and Biotechnology
Intermediate Chemical Experimentation
Laboratory Fundamentals in Biological Engineering
Personal Genomics and Medicine: What's in Your Genome?

Principles and Practice of Science Communication
Protein Folding, Misfolding and Human Disease
RNAi: A Revolution in Biology and Therapeutics
Technology in American History
Virus-host Interactions in Infectious Diseases
Graduate level
Biological Engineering Design
Design of Medical Devices and Implants
Development of Inventions and Creative Ideas
Environmental Conflict and Social Change
Genomics, Computing, Economics, and Society
Introduction to Global Medicine: Bioscience, Technologies, Disparities, Strategies
Medical Artificial Intelligence
Molecular Principles of Biomaterials
Organic Optoelectronics
Social Studies of Bioscience and Biotech
Undergraduate and Graduate levels
Bioinformatics and Proteomics
Genomics and Computational Biology
Molecular Structure of Biological Materials
Protein Folding Problem

Table 3: Course materials on Biotechnology existing at MIT Open Course Ware

Course materials on Biotechnology were found in three other providers. As the MIT model, registration is not available, only the materials, and more information can be seen in Table 4.

Course materials on Biotechnology	OER	Providers (total course materials)
Biotechnology Research and Development Model	CMAP; CMAT; STVI; MUAP	CTE ONLINE (33 course materials)
Maine Forest Bioproducts and Biotechnology	CMAP; CMAT;	MAINE Project Learning Tree (01 course material)
BIOL 211 – Majors Cellular [or Animal or Plant]	CMAP, CMAT, STVI	Open Course Library (80 course materials)

Table 4: Course materials on Biotechnology: Course titles, OER available and providers (total course materials)

Conclusions

There are some of the classic features about the process of teaching and learning that may change, potentially, with the OER movement. According to Santos (2012, p.72), this impact could be represented by three topics:

- Teacher and student roles: change from actors to authors within the process, both play learning and teaching activities;
- Reduction of the importance of the textbook with restricted rights to use caused by access to material from other authors and ability to create and re-create materials with more affinity to the cultural context in which the school institution is located;
- Open Education Practices (OEP): totally dependent on the OER movement and with many distinctive features of traditional education, including the freedom of the student deciding where to study, learning in a consistent manner with the pace needed for his life style ; the use of self-instruction and student-centered teaching practices;

For that, the three initials challenges might be answered.

The first answer was already frightening, despite the segmented search: Biotechnology and Courses. There were 40 sites where to get open course materials on Biotechnology and six sites where courses were available to receive enrollment. The language for all courses was English, only one course material was in Spanish and none in Portuguese. It is worrying because Fonseca et al. (2012, p. 374) identified the Internet as a source of information used most often by the Basic

Education teachers from Portugal to seek information on Biotechnology and it should be a global reality.

Apart from language difficulties, it was hard to imagine the starting point for a teacher who wants to adopt OER in Biotechnology for enhancing their educational practices. New challenges arise:

- What is the most appropriate online course model for teacher training? Long, generalist, as Saylor's Biotechnology course; or short and specialized, as Think Biotech?
- How to use the information of published curriculum maps to plan lessons?
- How to find, in this sea of resources, the desired material? What are the features of a desired material? How to evaluate its impact for quality education?
- How to adapt digital resources to each classroom? Can teachers make remixes at digital materials? Do teachers know about the licensing rules applied to OER?

Academic community should help teachers to confront these challenges and rebuild the school identity, according to the Open Education Practices.

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Degree in Biological Sciences (full degree) in 1998 by the Federal University of Rio de Janeiro (UFRJ), attended the Masters in Education at the Pontifical Catholic University of Rio de Janeiro (PUC - Rio), was a Biology teacher between 2000 and 2008. Since then, works at the Brazilian Institute of Metrology (Inmetro) as executive analyst in metrology and quality in the Optical Metrology Division (Scientific and Industrial Metrology). In 2013, started the Doctorate degree in Biotechnology, inside The Graduate Program in Biotechnology of the National Institute of Metrology, Quality and Technology - Inmetro. In the same year, her project, entitled Open Educational Resources on Biotechnology and Basic Industrial Technology in an Interdisciplinary Perspective, received funds from The National Council for Scientific and Technological Development (CNPq/Brasil). Some preliminary results will be presented at IX INTERNATIONAL CONFERENCE GUIDE. In 2015, was nominated for the organizing committee in the biannual event of the Brazilian Society for Metrology - Metrology 2015 – it will be held in Bento Gonçalves under the theme: Better measurements, more quality, more reliable! Since 2009, is participating in the organizing committees of The World Forum of Vocational and Technical Education (FMEPT).

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